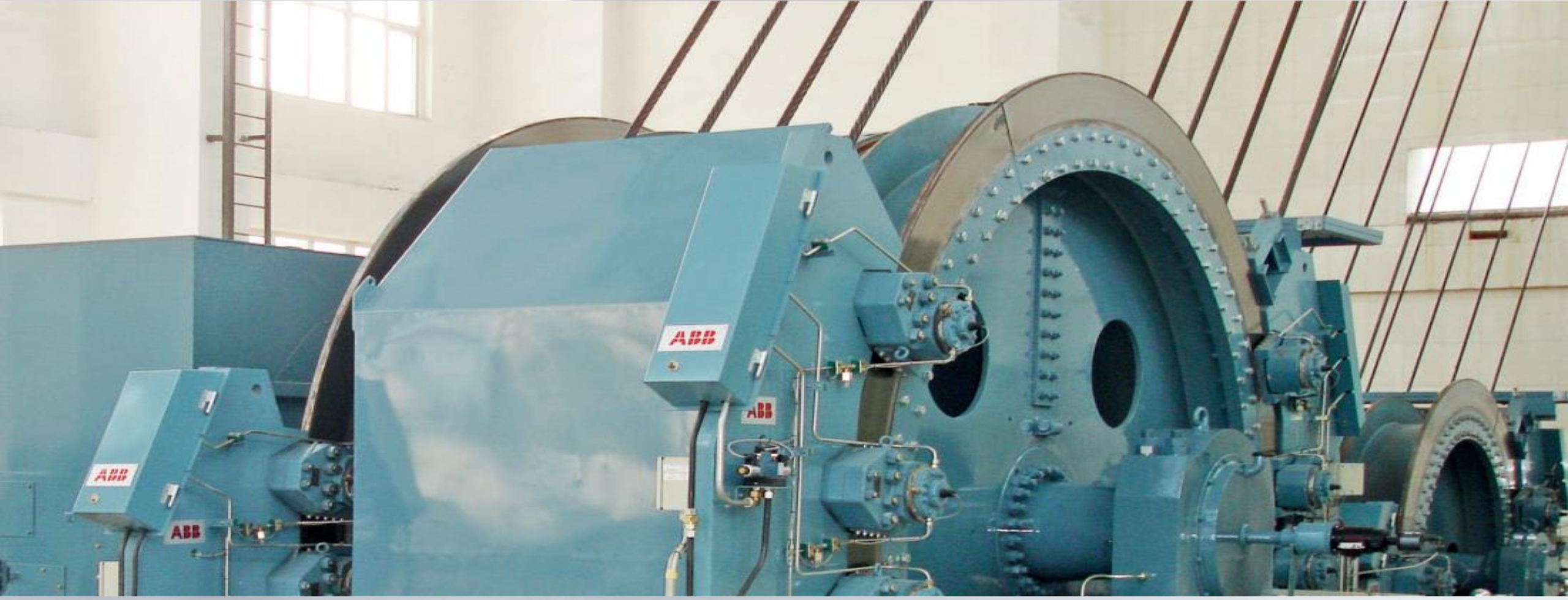

22-24 OCTOBER 2024

Towards Mechanical Digitalization of Mine Hoist with COMSOL

COMSOL Conference 2024, Florence

Krystof Kryniski, Sean Martin, Jacob Van Wyk, Mike Davis, Tim Gartner

About ABB

ABB in numbers 2023

- ABB solutions connect engineering know-how and software to optimize how things are manufactured, moved, powered and operated.
- In collaboration with the customers, partners and suppliers, ABB address the world's energy challenges, transform industries and embed sustainability in everything.

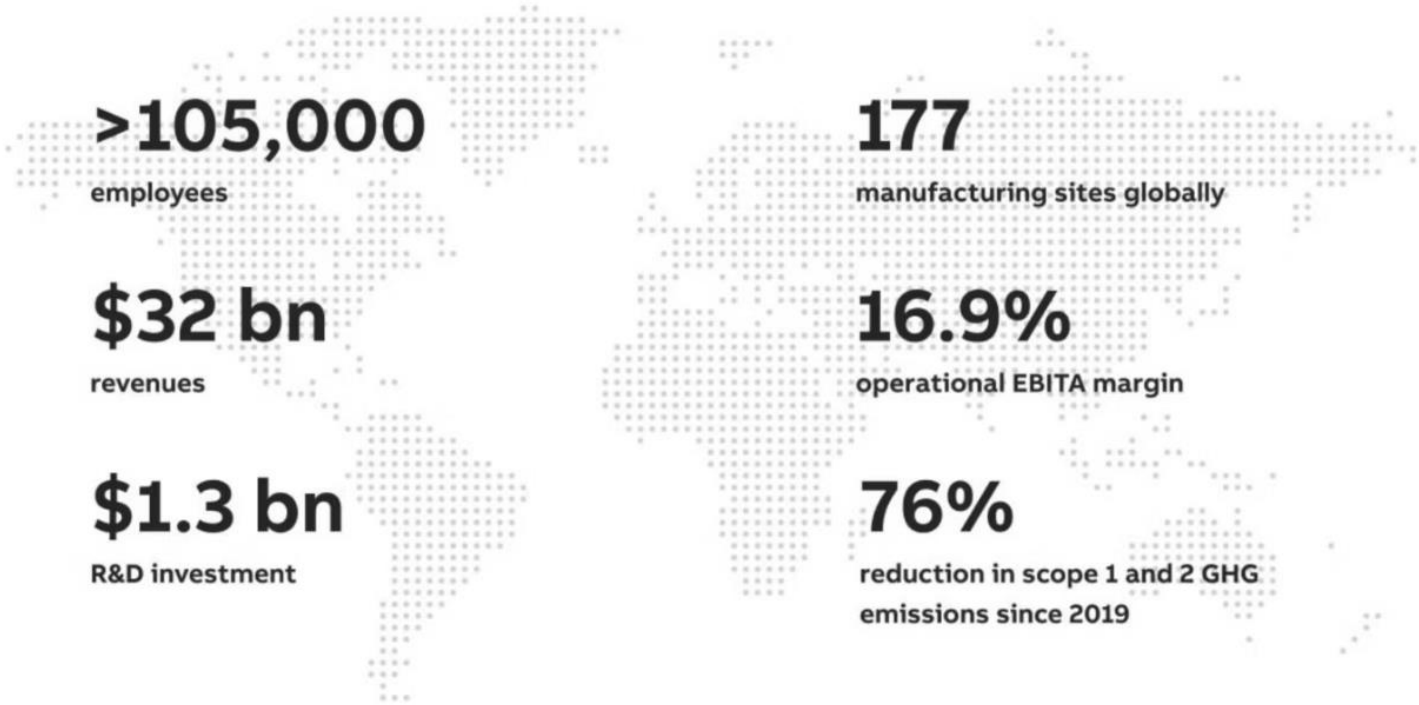

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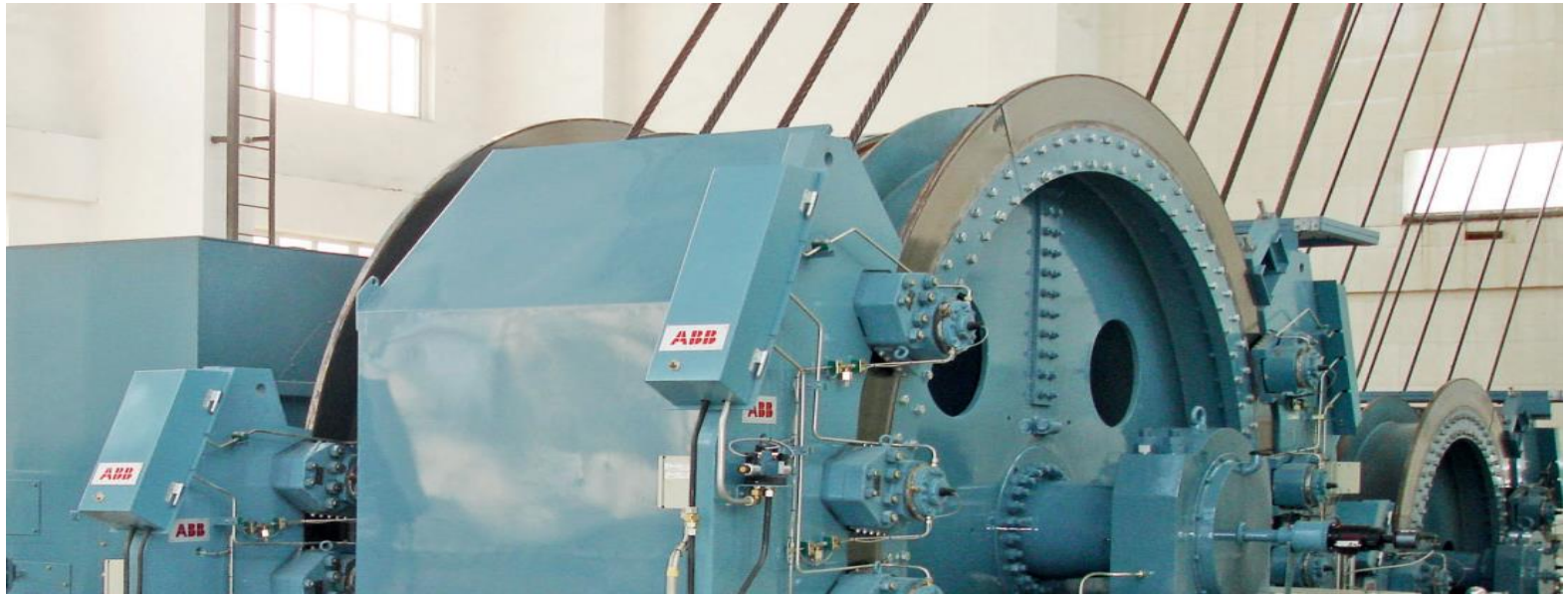
ABB MINING HOISTS

So, Let’s focus on it

Mine hoist is significant capital investments. Its efficient, safe, and reliable operation are of vital importance to mining companies. ABB delivers one of the largest units covering hoisting system , motors, control systems e.g., the ACS 6000 MV drives, break control system and related technical support.

- Drums of diameter up to 5.7 m
- ACS 600 for 3-36 MW motors
- Payload up to 45 t with average payload up to 1530 tph

NO UNPLANNED DOWNTIMES !



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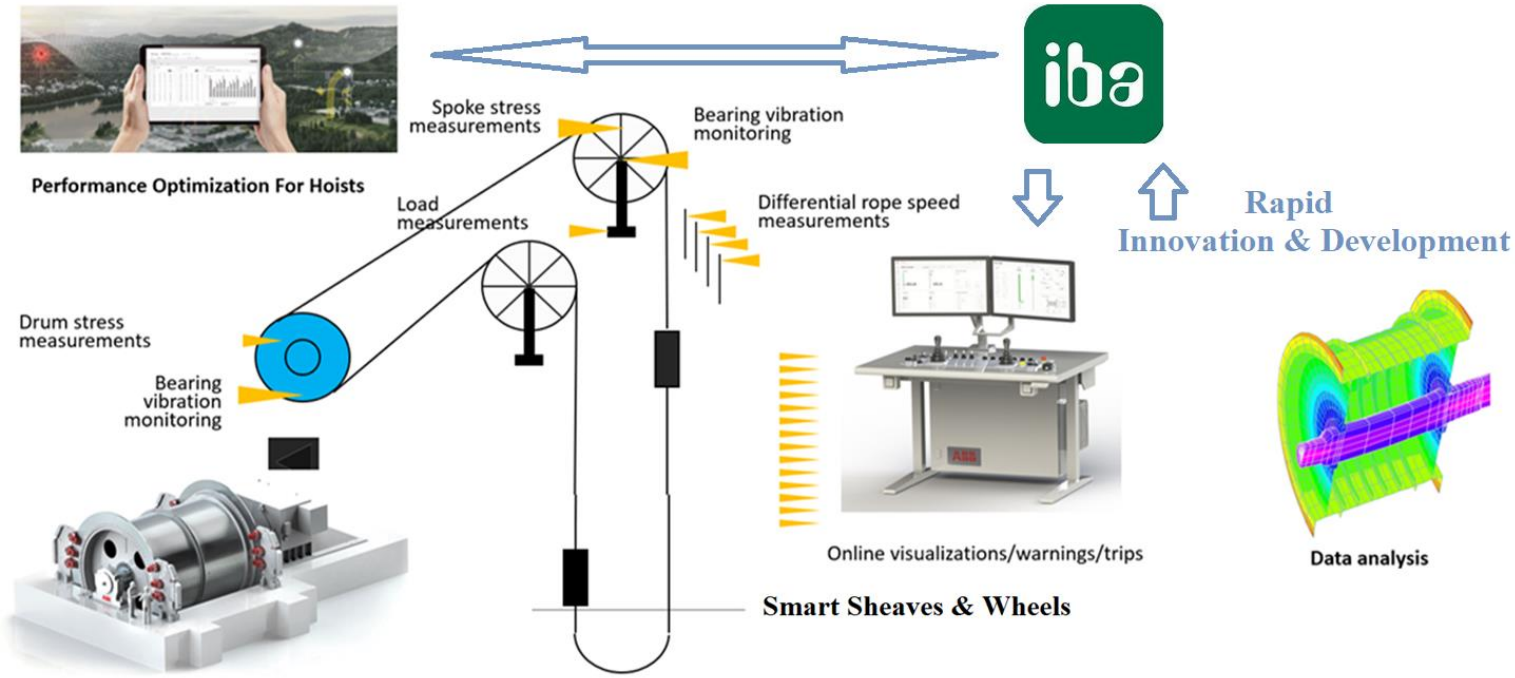
MECHANICAL DIGITALIZATION

ABB Vision on Mine Hoist Monitoring

- Conventional process of mechanical design assumes predetermined, limited numbers of hoist load cycles.
- After the initial design and commissioning of the mine hoist, the mechanical strain within the hoist components is usually no longer monitored.
- It is generally assumed that the safety factors incorporated into the design are sufficient to ensure the safe operation of the mine hoist throughout its lifecycle.

New generation of hoists is going to be equipped with stress/vibration monitoring systems that continuously feed data into advanced models.



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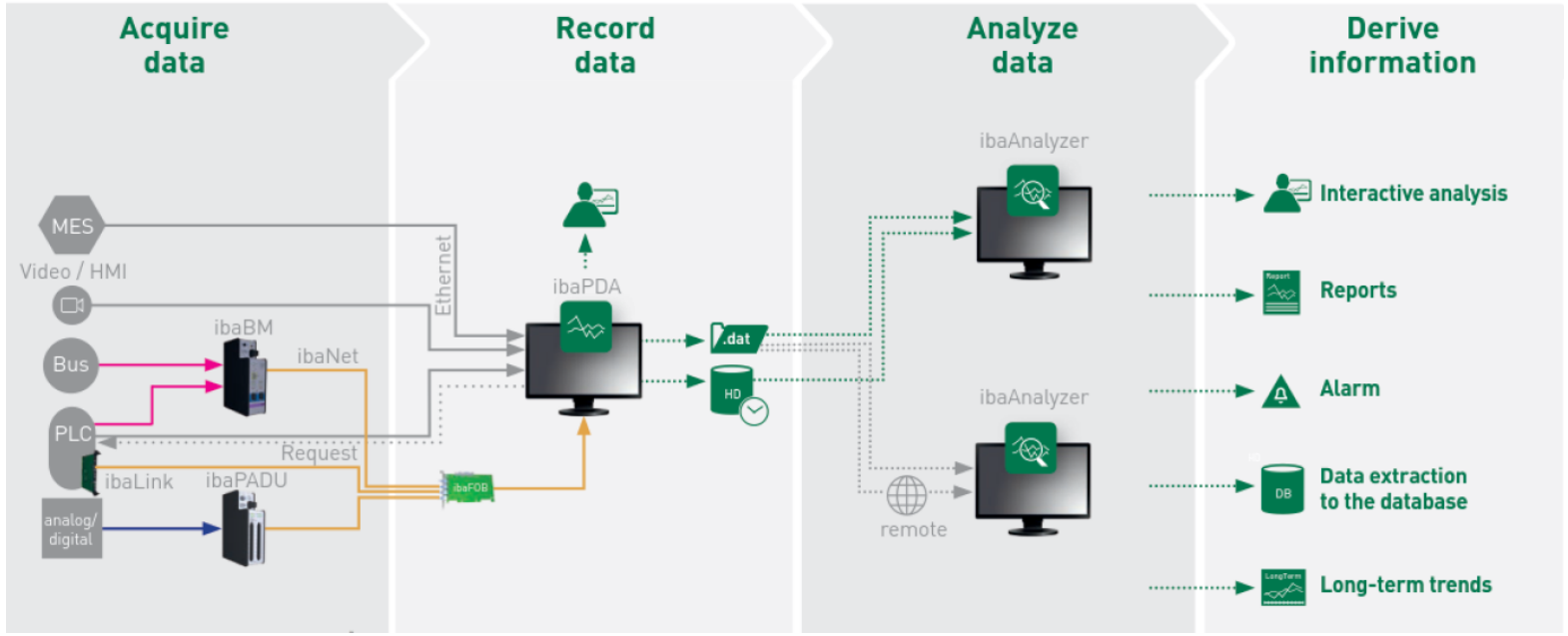
IBA BASED MONITORING SYSTEM

Rapid Innovation & Development

PLUG & PLAY

- To stay ahead, research must have access to a dedicated, flexible, and powerful platform that can seamlessly integrate with existing industrial systems.
- This would enable rapid testing and validation of new algorithms in real-world environments.
- We must ensure technological advancements are not only theoretical but also practically applicable.

IBA SYSTEM



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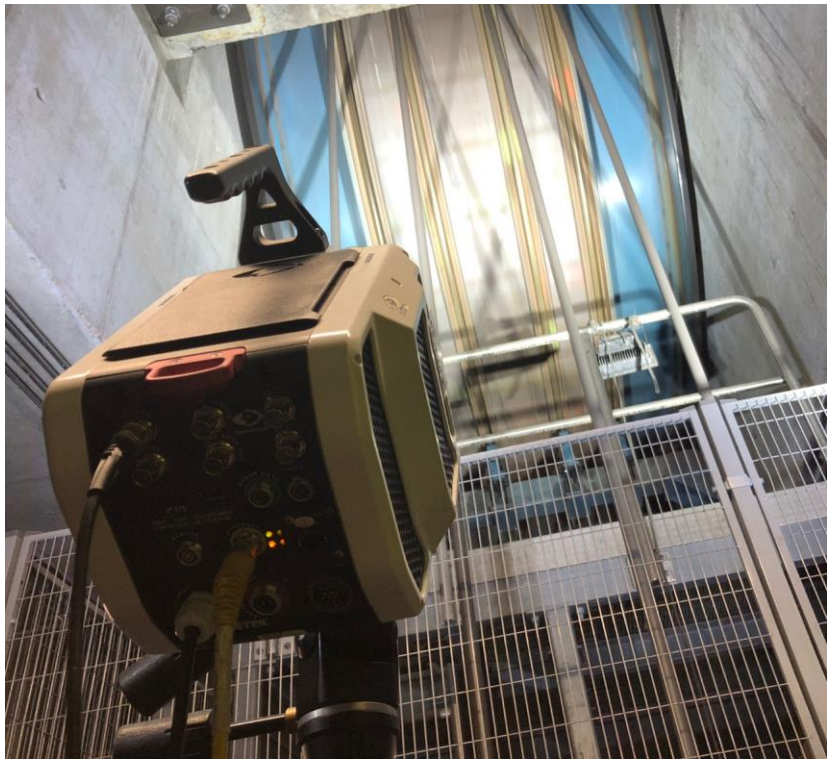
ADVANCED SENSING TECHNOLOGY

State-of-Art Sensors & Advanced Processing

IRIS-M Camera & KALMAN Order Tracking

Wireless, Multi-Channel Stress/Motion Sensors

Vision & Advanced Image Processing



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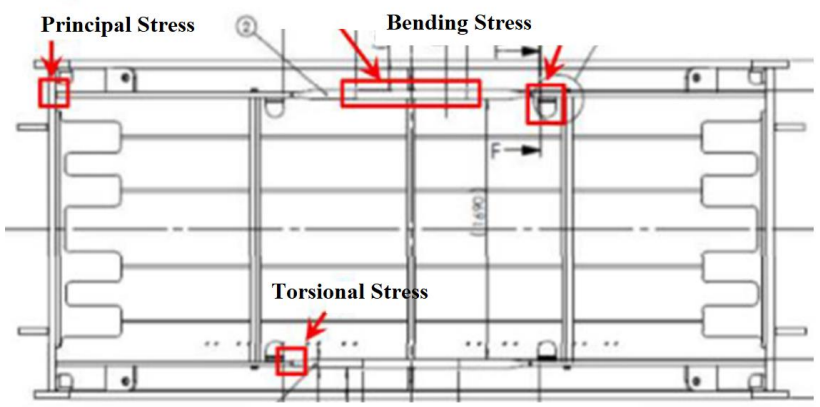
COMSOL PROTOTYPING

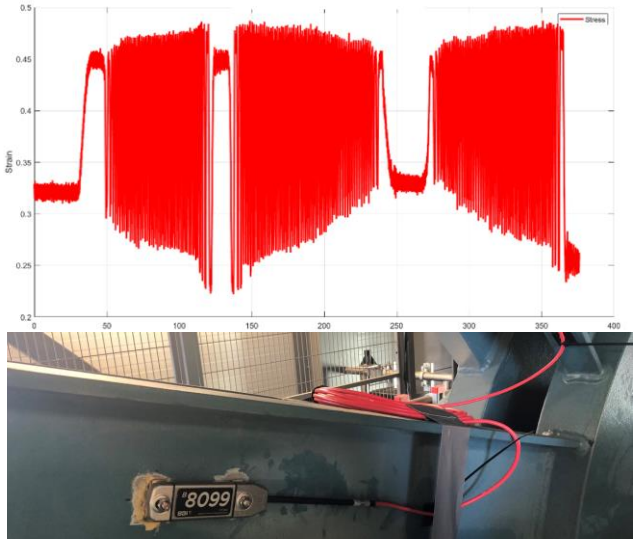
Stress Distribution & Life Assessment

Stress Distribution & Life Assessment



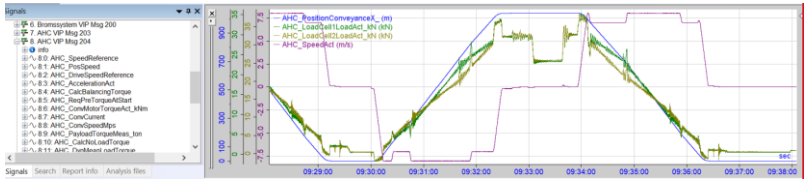
- Bending stresses in the drum
- Torsional stresses on a driving shaft
- Combined stress on the drum cheek

Virtual Sensors & Cross-Relations



- Stress & vibration signals well-synchronized with OPC parameters-

Mechanical Digital Twin



- OPC data available as the INPUT
- Synchronized field data as OUTPUT
- Data simulated via validated models
- Surrogate Model Training
- Optimization of the hoist performance.

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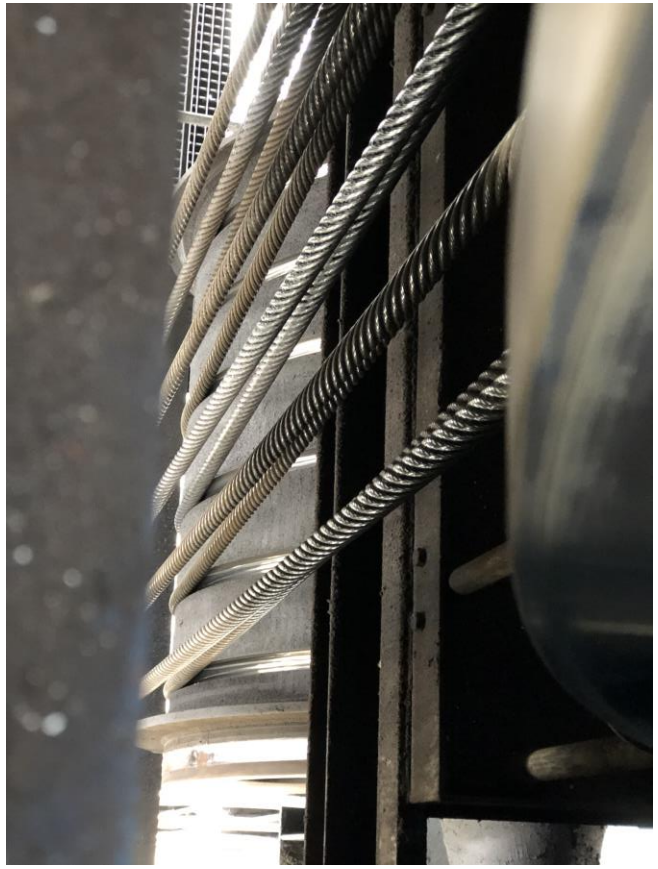
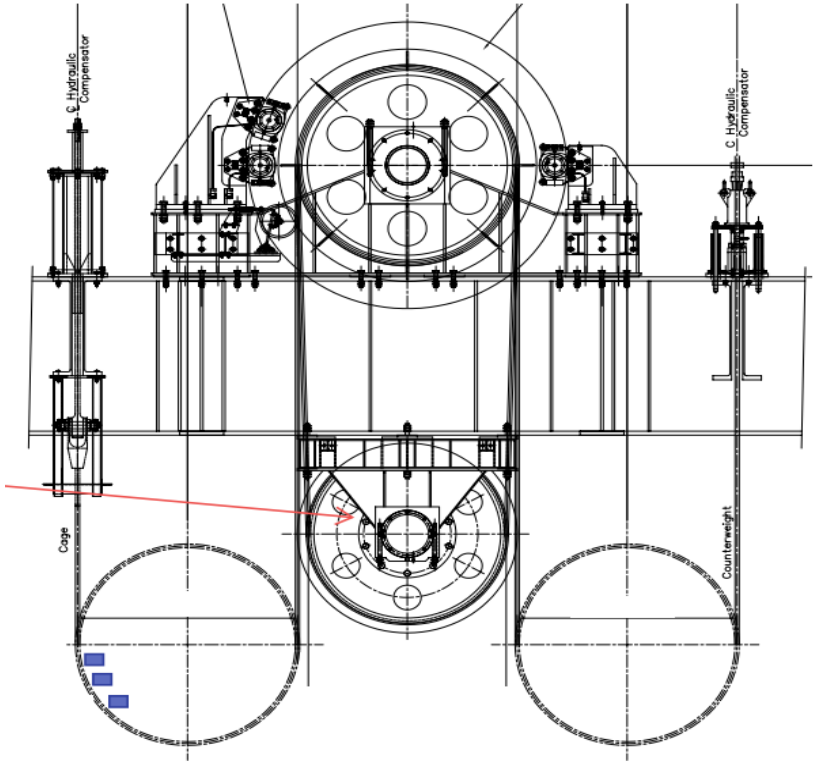
COMSOL PROTOTYPING

Structural Modelling & Life Assessment

Structural modelling in COMSOL is highly effective for simulating mechanical structures, analysing their behaviour under various loads, constraints, and environmental conditions, and assessing their long-term durability and reliability. The software enables rapid insights into hoist components or similar systems with relatively low computational power, making it efficient for both detailed analysis and operational life assessment.



Koepe Winder



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COMSOL PROTOTYPING

Structural Mechanics & Life Assessment

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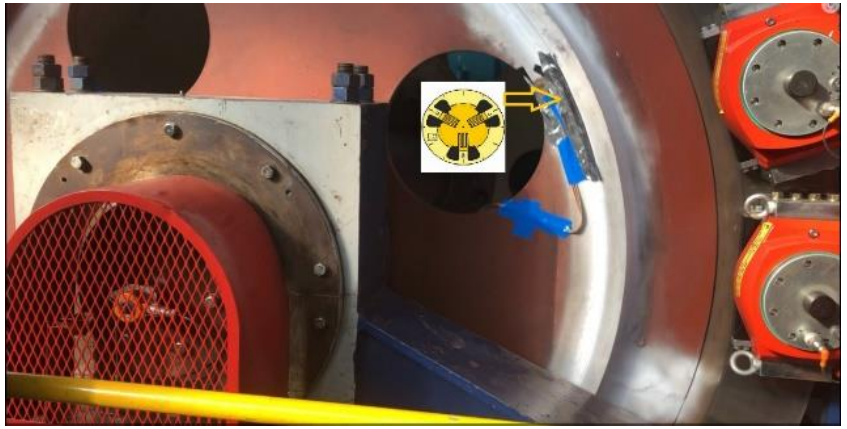

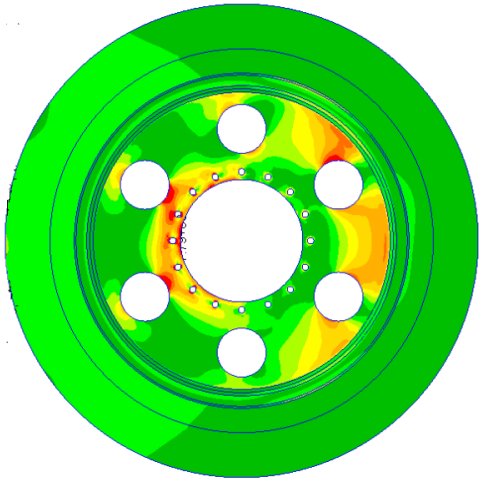

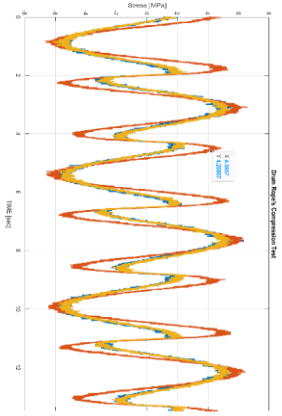

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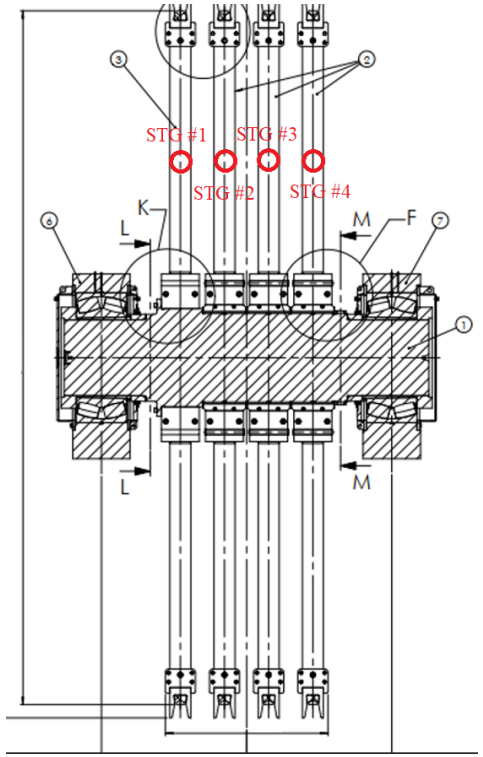
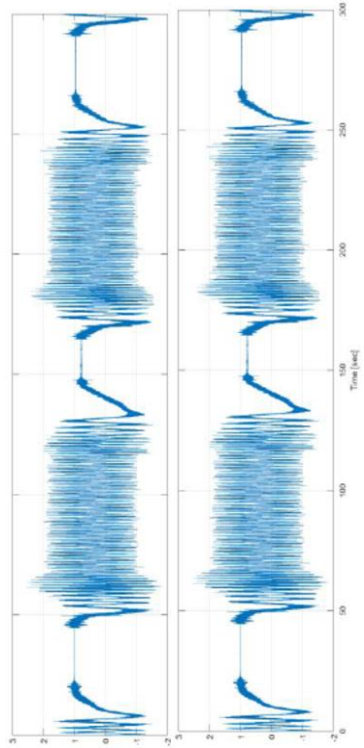
COMSOL PROTOTYPING

Virtual Sensors & Cross-Relations

Virtual sensors use models or algorithms to estimate physical quantities that are difficult or costly to measure directly. COMSOL enables the streaming of data such as stress, temperature, and displacement at specific locations, allowing for efficient monitoring and performance optimization without physical sensors. Additionally, COMSOL reveals mutual relationships between variables, enabling the creation of sensitivity and cross-correlation matrices for deeper analysis.



Improper Tension/Rope Slippage



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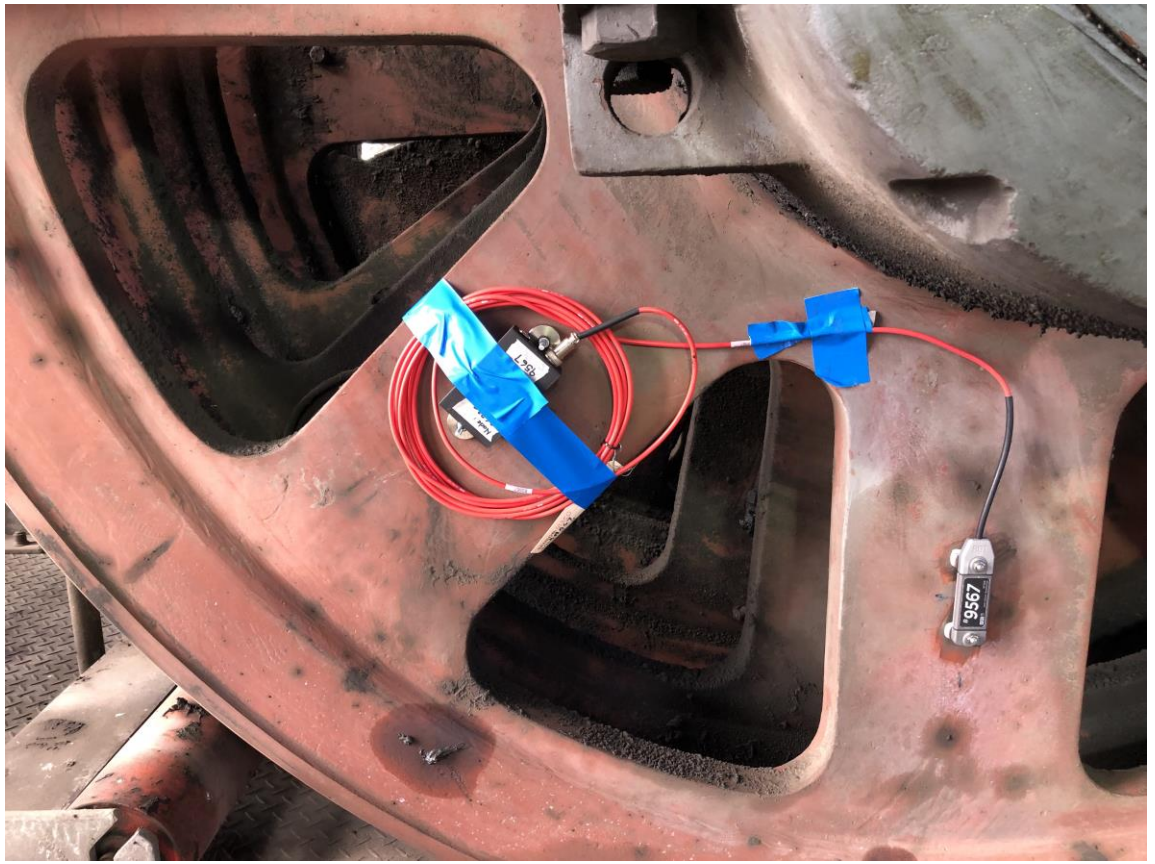

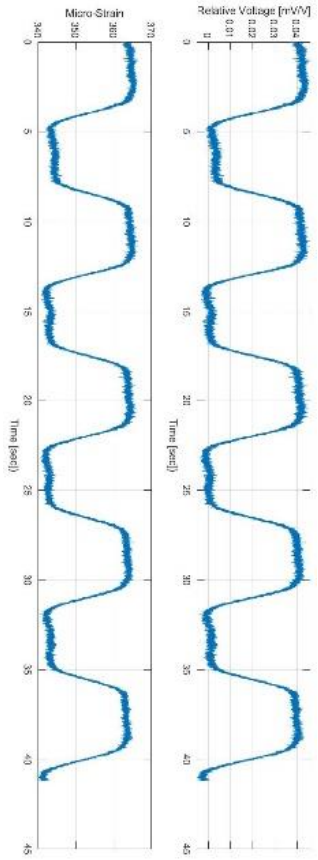

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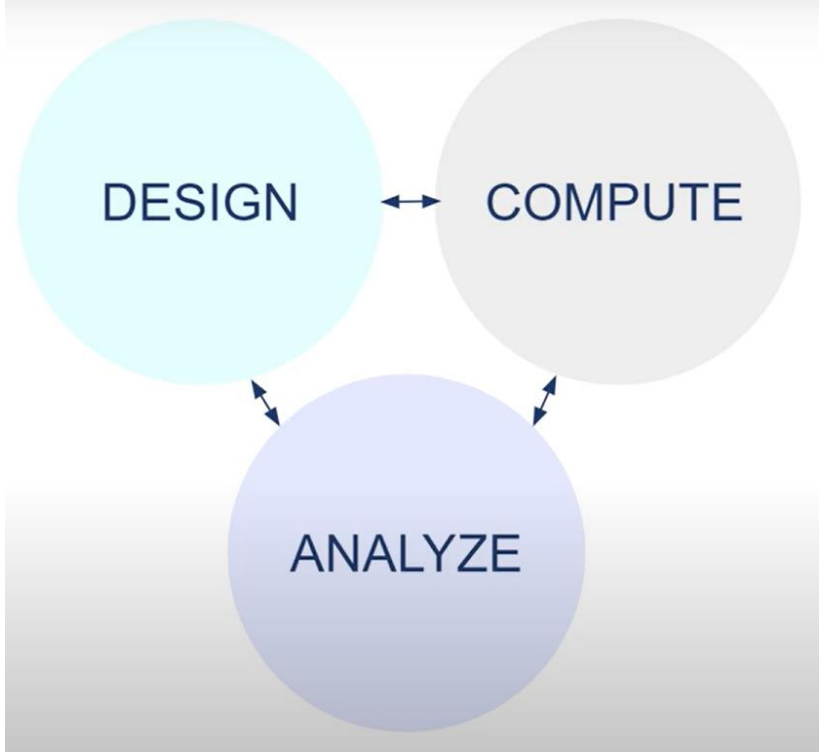
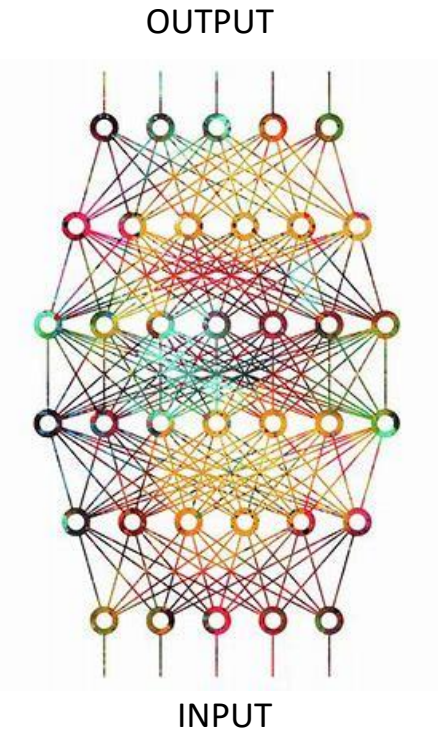
COMSOL PROTOTYPING

Industrial Modelling

Computationally expensive models can be approximated using surrogate models, also known as reduced-order models. These surrogates provide an efficient alternative to the full model by using machine learning algorithms, such as regression and neural networks, to fit the model based on data set. Once trained and validated, the surrogate model can be employed for rapid predictions, design optimization, and sensitivity analysis, significantly reducing computational costs and time.

PERFORMANCE OPTINIZATION OF HOISTS





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RINDÖ 2025

Extended Mate Connector

ONSHAPE

ONSHAPE is CAD software, delivered over the Internet via SaaS model. It makes extensive use of cloud computing, with compute-intensive processing and rendering performed on Internet-based servers, and users are interacting with the system via a web browser.

ONSHAPE is NOT a Multiphysics Solution

Concept of MATE CONNECTORS

Mate connectors are local coordinate system entities located on or between entities. They are used within a mate to locate and orient instances with respect to each other. You can also use mate connectors to create planes.

COMSOL

Importing geometry objects from a 3D CAD file into COMSOL is seamless. However, setting boundary conditions and loads can be more complex and less intuitive

COMSOL is NOT a CAD Solution

One of the key objectives of the RINDÖ project is to develop an extension for the mate connector automatically handling the loads and reactions between adjacent entities. Experimental validation is a MUST.

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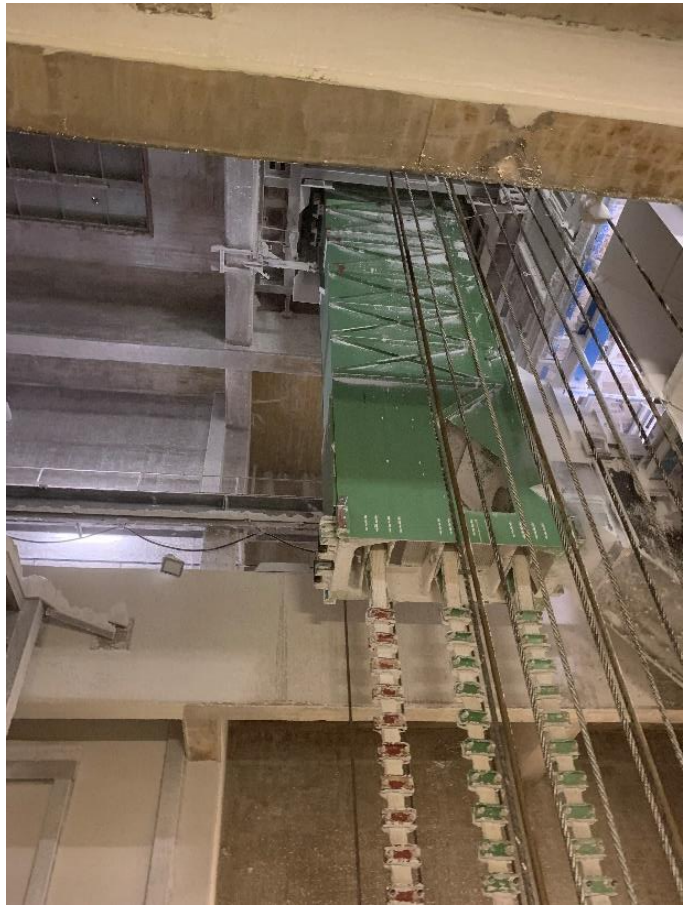
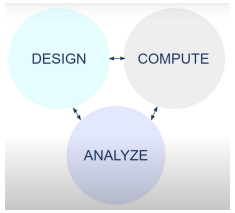
RINDÖ 2025

Potential Industrial Case

- ABB is engaged in designing new skips for German potash mines, ensuring compliance with EUROCODE 3 standards.
- The customer’s current skips have shown signs of minor cracking in their structure.
- In response, the customer has requested a series of stress and vibration measurements to serve as the foundation for the calculations needed to develop new skips that are more resistant to cracking.





- VIBRATION: 3-directional accelerometers
- PRINCIPAL STRESSES: Rosette Strain-gauges
- High-speed DAQ, remotely controlled
- DATA: Several operational cycles for loaded and unloaded conditions.

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Q&A

ABB